

# PATENT ABSTRACTS OF JAPAN

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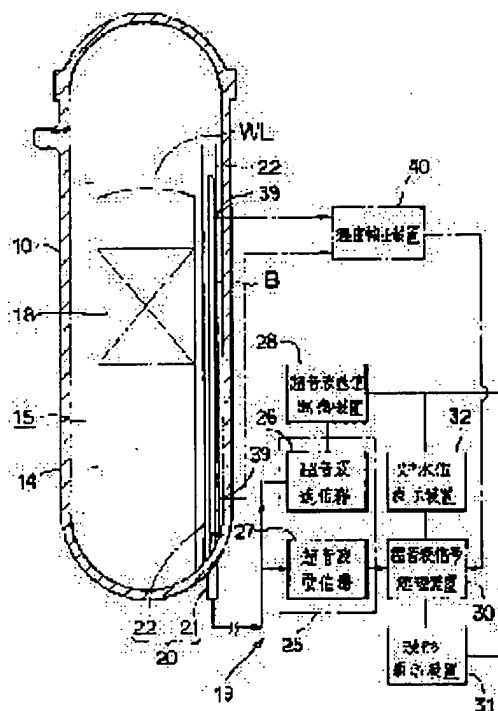
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## (54) WATER LEVEL MEASURING APPARATUS FOR NUCLEAR REACTOR

### (57)Abstract:

**PURPOSE:** To obtain a water level measuring apparatus for a nuclear reactor which achieves an accurate measurement of the water level of the nuclear reactor with one measuring system utilizing an ultrasonic wave without requiring an instrument piping.

**CONSTITUTION:** In a water level measuring apparatus for a nuclear reactor, an ultrasonic waveguide 22 having a side hole is erected in a pressure vessel 10 and an ultrasonic transducer 21 is mounted aligning the center axis of the ultrasonic waveguide 22 to form an ultrasonic propagation system 20. On the other hand, an ultrasonic transmitting/receiving means 25 is connected to an ultrasonic transducer 21 and an ultrasonic transmission controller 28 is connected thereto 25. An ultrasonic signal processor 30 is connected to both of the ultrasonic transmission controller 28 and the ultrasonic transmitting/receiving means 25 and a reactor water level display device 32 is provided to display a water level of the reactor as processed and calculated with the ultrasonic signal processor.



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**CLAIMS**

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**[Claim(s)]**

[Claim 1] The ultrasonic waveguide which has a side hole is set up in a reactor pressure vessel. To this reactor pressure vessel an ultrasonic transducer The ultrasonic transceiver means connected to said ultrasonic transducer while it attached and the ultrasonic propagation system was constituted so that it might be in agreement with the medial-axis line of the above-mentioned ultrasonic waveguide, The ultrasonic transmission-control equipment connected to this ultrasonic transceiver means, and the ultrasonic signal processor connected to the both sides of this ultrasonic transmission-control equipment and an ultrasonic transceiver means, At least the atomic furnace water to which at least the furnace water which displays at least the furnace water which signal processing was carried out and was computed with this ultrasonic signal processor is characterized by having a display is a metering device.

[Claim 2] At least the reactor water according to claim 1 which an ultrasonic propagation system pierces through and arranges the downcomer section formed of a reactor pressure vessel and a reactor core shroud, and has the shaft-orientations die length which projects more nearly up than the furnace water side of the high end which an ultrasonic waveguide pierces through the inside of furnace water, and is expected is a metering device.

[Claim 3] At least the reactor water according to claim 1 which formed the temperature proofreading equipment which detects the temperature of furnace water to an ultrasonic waveguide, and outputs a proofreading temperature signal to it, and connected this temperature proofreading equipment to the ultrasonic signal processor is a metering device.

[Claim 4] The ultrasonic waveguide which has a side hole is set up in a reactor pressure vessel. To this reactor pressure vessel an ultrasonic transducer While it attaches and an ultrasonic propagation system is constituted so that it may be in agreement with the medial-axis line of the above-mentioned ultrasonic waveguide An ultrasonic beam reflective means to make said ultrasonic waveguide reflect a part of ultrasonic incident beam is installed inside the location which was able to be decided beforehand. At least the atomic furnace water characterized by constituting so that at least furnace water may be calculated from the reflective echo wave propagation time amount reflected from the reflective echo wave generated with the above-mentioned ultrasonic beam reflective means and a furnace water side is a metering device.

[Claim 5] At least the reactor water according to claim 4 set up so that it might install inside two or more locations which were able to determine beforehand an ultrasonic beam reflective means to make an ultrasonic waveguide reflect a part of ultrasonic incident beam, respectively, the propagation time of the ultrasonic pulse reflected from each above-mentioned ultrasonic beam reflective means might be compared with the propagation time of the surveyed ultrasonic pulse and metering devices, such as an ultrasonic transducer, might be proofread is a metering device.

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## DETAILED DESCRIPTION

### [Detailed Description of the Invention]

[0001]

[Industrial Application] At least the atomic furnace water of the ultrasonic type at which this invention measures at least the furnace water of reactors, such as a boiling water reactor, is related with a metering device.

[0002]

[Description of the Prior Art] As at least the conventional atomic furnace water in a boiling water reactor shows a metering device to drawing 12, it is a differential pressure type thing. Instrument wiring 2 and 3 is connected to the upper part and the lower part of a reactor pressure vessel 1 of a boiling water reactor, respectively, the condensation tub 4 is connected to the upside instrument wiring 2, it connects a differential pressure gage 5 to the lower instrument wiring 3, respectively, and, as for a metering device, at least this reactor water connects the condensation tub 4 and a differential pressure gage 5 by instrument wiring 6.

[0003] At least the water of reactor furnace water converts change into water pressure, and a metering device measures [ change ] at least conventional differential pressure type atom furnace water for it.

[0004] As for the steam from the upside instrument wiring 2, at least this differential pressure type atom furnace water changes with condensation tubs 4 to water in a metering device, and the vapor pressure in the condensation tub 4 is always kept constant. Therefore, the fixed water pressure which added a part for the pressure of the water column of instrument wiring 6 is applied to a differential pressure gage 5 via the instrument wiring 6 connected to the condensation tub 4. Furnace pressure acts on this differential pressure gage 5 through the lower instrument wiring 3, and the water pressure proportional to the height of the furnace water of a reactor is applied.

[0005] When the furnace water level of a reactor falls, the water pressure of instrument wiring 3 decreases and the differential pressure in a differential pressure gage 5 increases. Moreover, when the furnace water level of a reactor increases, the water pressure of instrument wiring 3 increases and the differential pressure in a differential pressure gage 5 decreases. As for a metering device, at least the water of reactor furnace water converts change into water pressure at least for this reactor water, and at least water is measuring.

[0006]

[Problem(s) to be Solved by the Invention] In order that at least conventional reactor water may measure at least furnace water in a metering device, instrument wiring 2, 3, and 6 is used. Moreover, by the measurable pressure range, three kinds for for example, the object for high pressures, the object for medium voltages, and low voltage are needed, and the quantity of instrument wiring also increases a differential pressure gage in proportion to the increment in the class of differential pressure gage. For this reason, much instrument wiring will be installed in a reactor pressure vessel 1, and there was a fault, like the structure of a reactor becomes complicated for measurement like furnace water.

[0007] This invention was not made in consideration of the situation mentioned above, and does not need instrument wiring, but aims to let at least the atomic furnace water which can measure at least the

furnace water of a reactor with a sufficient precision by one system of measurement using a supersonic wave offer a metering device.

[0008] Other purposes of this invention have at least atomic furnace water which can be measured without crossing at least the furnace water of a reactor to the large stage measurement range, and being influenced of the temperature distribution of furnace water in offering a metering device.

[0009] Other main purposes of this invention have at least atomic furnace water which can measure at least the furnace water of a reactor simply and correctly in offering a metering device, without performing temperature compensation of furnace water.

[0010] As for still more nearly another purpose of this invention, at least the atomic furnace water which can perform proofreading of an ultrasonic transducer, the check of the measurable range of furnace water, etc. from an ultrasonic transducer, without removing from a reactor pressure vessel offers a metering device.

[0011]

[Means for Solving the Problem] In order that a metering device may solve the technical problem mentioned above, at least the reactor water concerning this invention The ultrasonic waveguide which has a side hole as indicated to claim 1 is set up in a reactor pressure vessel. The ultrasonic transceiver means connected to said ultrasonic transducer while the ultrasonic transducer was attached in this reactor pressure vessel so that it might be in agreement with the medial-axis line of the above-mentioned ultrasonic waveguide, and the ultrasonic propagation system was constituted in it, At least the furnace water which displays at least the furnace water which signal processing was carried out and was computed with the ultrasonic transmission-control equipment connected to this ultrasonic transceiver means, the ultrasonic signal processor connected to the both sides of this ultrasonic transmission-control equipment and an ultrasonic transceiver means, and this ultrasonic signal processor has a display.

[0012] Moreover, in order to solve the technical problem mentioned above, arrange an ultrasonic propagation system, and as at least the atomic furnace water of this invention indicated the metering device to claim 2, as it pierces through the downcomer section formed of a reactor pressure vessel and a reactor core shroud and being indicated to claim 3, the temperature proofreading equipment which detects the temperature of furnace water to a waveguide and outputs a proofreading temperature signal to it forms, and this temperature proofreading equipment connects to an ultrasonic signal processor.

[0013] At least the atomic furnace water concerning this invention furthermore, a metering device In order to attain other main purposes mentioned above, as indicated to claim 4 The ultrasonic waveguide which has a side hole is set up in a reactor pressure vessel. To this reactor pressure vessel an ultrasonic transducer While it attaches and an ultrasonic propagation system is constituted so that it may be in agreement with the medial-axis line of the above-mentioned ultrasonic waveguide It installs inside the location which was able to determine beforehand an ultrasonic beam reflective means to make said ultrasonic waveguide reflect a part of ultrasonic incident beam, and it constitutes so that at least furnace water may be calculated from the reflective echo wave propagation time amount reflected from the reflective echo wave generated with the above-mentioned ultrasonic beam reflective means, and a furnace water side.

[0014] It sets up so that an ultrasonic beam reflective means make an ultrasonic waveguide reflect a part of ultrasonic incident beam further again as at least this reactor water indicated the metering device to claim 5 may be installed inside two or more locations which were able to be decided beforehand, respectively, the propagation time of the ultrasonic pulse reflected from each above-mentioned ultrasonic beam reflective means may be compared with the propagation time of the surveyed ultrasonic pulse and metering devices, such as an ultrasonic transducer, may be proofread.

[0015]

[Function] A metering device controls ultrasonic transmission-control equipment, and from an ultrasonic transceiver means, at least this reactor water oscillates a supersonic wave for an electrical signal from delivery and an ultrasonic transducer to in a reactor pressure vessel to the ultrasonic transducer of an ultrasonic propagation system, and carries out incidence of the oscillated supersonic wave to an ultrasonic waveguide.

[0016] The supersonic wave by which incidence was carried out into the ultrasonic waveguide spreads the inside of an ultrasonic waveguide, without beam width's not spreading and being influenced of the temperature distribution in reactor furnace water, and reflects it in respect of reactor furnace water. Incidence of the supersonic wave reflected in respect of furnace water is again carried out to an ultrasonic transducer via an ultrasonic waveguide and a reactor pressure vessel. Signal processing of the ultrasonic echo by which incidence was carried out to the ultrasonic transducer is inputted and carried out to an ultrasonic signal processor from an ultrasonic transceiver means, and at least furnace water is computed.

[0017] While at least furnace water is inputted into a display, as for the ultrasonic signal by which data processing was carried out with this ultrasonic signal processor, an ultrasonic transmitting start signal is inputted into a display or an ultrasonic signal processor at least for this furnace water from ultrasonic transmission-control equipment. By measuring the time interval of these ultrasonic signals and ultrasonic start signals, data processing is carried out, at least atomic furnace water is computed and at least the computed furnace water is displayed at least for furnace water with a display.

[0018] Moreover, a metering device installs at least this reactor water inside the location which was able to determine beforehand an ultrasonic beam reflective means to make an ultrasonic waveguide reflect a part of ultrasonic incident beam. Since it constituted so that at least furnace water might be calculated from the reflective echo wave propagation time amount reflected from the reflective echo wave and furnace water side which are reflected from this ultrasonic beam reflective means, even if it is not necessary to perform temperature proofreading of furnace water and does not perform temperature proofreading of furnace water At least the furnace water of a reactor can be measured correctly and easily.

[0019] Moreover, if an ultrasonic beam reflective means to make an ultrasonic waveguide reflect a part of ultrasonic incident beam is installed inside two or more locations which were able to be decided beforehand, the propagation time of the ultrasonic pulse reflected from each ultrasonic beam reflective means is compared with the propagation time of the surveyed ultrasonic pulse, and metering devices, such as an ultrasonic transducer, can be proofread.

[0020]

[Example] Hereafter, at least the atomic furnace water concerning this invention is explained with reference to an accompanying drawing about one example of a metering device.

[0021] Drawing 1 is drawing in which at least the atomic furnace water which used the ultrasonic pulse echo method shows the principle of a metering device.

[0022] At least this ultrasonic reactor water installed the ultrasonic transducer 11 in the reactor pressure vessel 10, and the metering device connected the ultrasonic transmitter-receiver 12 to this ultrasonic transducer 11, and has controlled the oscillation of the supersonic wave from the ultrasonic transducer 11 by this ultrasonic transmitter-receiver 12.

[0023] If an electric pulse signal is added to the ultrasonic transducer 11 from the ultrasonic transmitter-receiver 12, ultrasonic beam B will be oscillated. While this ultrasonic beam B enters in a reactor pressure vessel 10 and it is spread to the furnace water side WL through the downcomer section 15 between a reactor pressure vessel 10 and the reactor core shroud 14, it reflects in respect of [ WL ] furnace water, and incidence of the spread ultrasonic beam B is again carried out to the ultrasonic transducer 11.

[0024] Through the ultrasonic transmitter-receiver 12, the ultrasonic echo signal from the ultrasonic transducer 11 is inputted into the wave displays 17, such as an oscilloscope, and it is indicated by the wave. The output wave displayed on the wave display 17 is expressed as shown in drawing 2. In addition, a sign 18 is a main steam nozzle.

[0025] If the output wave expressed to drawing 2 is observed, since the time interval T of the ultrasonic echo signal E serves as the propagation time of a round trip of an ultrasonic beam, the distance L from the ultrasonic transducer 11 to the furnace water side WL is calculated by the degree type.

[0026]

[Equation 1]  $L = V \cdot T / 2$  ..... (1)

V is underwater acoustic velocity (m/sec) here, and they are about 1500 m/sec in ordinary temperature.

[0027] Thus, the water level of reactor furnace water is measured from (1) type.

[0028] It is calculable, when at least ultrasonic type water converts level WL and at least the water of reactor furnace water converts the propagation time of ultrasonic beam B in a metering device.

therefore, the thing which the received ultrasonic echo is detected by one ultrasonic transducer, and is done for signal processing of the detected ultrasonic echo signal E -- the water level of furnace water -- it can measure -- the conventional differential pressure type -- water level -- like a metering device, the instrument wiring which has two or more measurement ranges becomes unnecessary.

[0029] At least the atomic furnace water concerning this invention adapting this measurement principle explains one example of a metering device 20 with reference to drawing 3.

[0030] As for a metering device 19, at least this reactor water is attached to the reactor pressure vessel 10 of a boiling water reactor. In a reactor pressure vessel 10, the reactor core 18 which loaded many nuclear fuels (fuel assembly) is held, and this reactor core 18 is surrounded by the reactor core shroud 14. The annular downcomer section 15 is formed between the reactor core shroud 14 and a reactor pressure vessel 10.

[0031] One ultrasonic propagation system 20 which makes ultrasonic beam B scan in the vertical direction is formed in this downcomer section 15. This ultrasonic propagation system 20 has the ultrasonic transducer 21 which oscillates an ultrasonic pulse, and the ultrasonic waveguide 22 to which it shows the beam B of the oscillated ultrasonic pulse.

[0032] While being set up by the inside of a reactor pressure vessel 10, the ultrasonic waveguide 22 places the downcomer section 15, is prolonged up, and the upper limit is projected above the furnace water side WL, and is carrying out termination, and it is carrying out opening. the ultrasonic waveguide 22 -- < -- A HREF="/Tokujitu/tjitemdrw.ipdl?N0000=237&N0500=1E\_N/?:=8<? -- <

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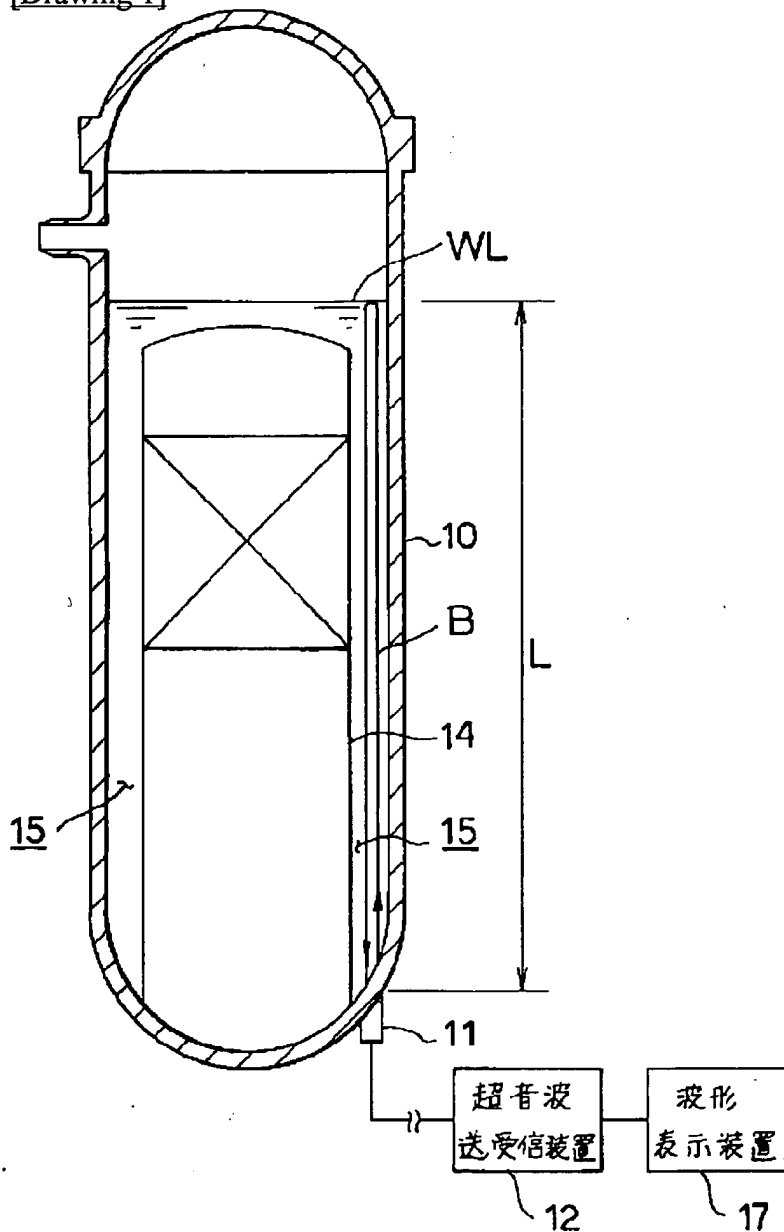
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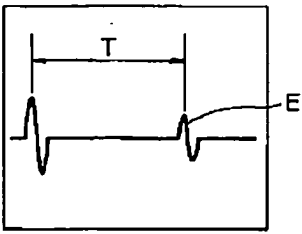
DRAWINGS

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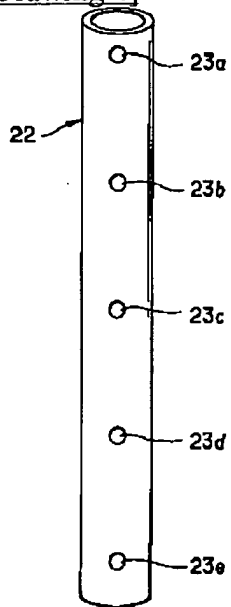
[Drawing 1]



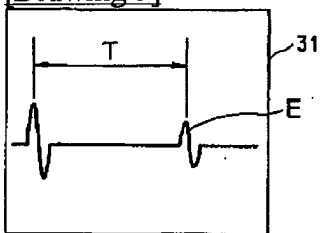
[Drawing 2]



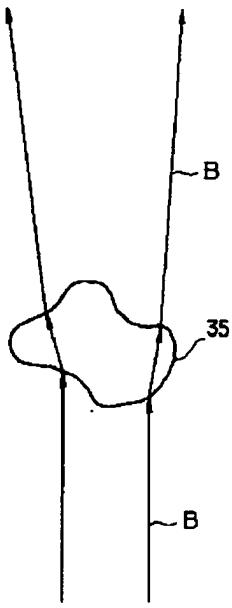
[Drawing 4]



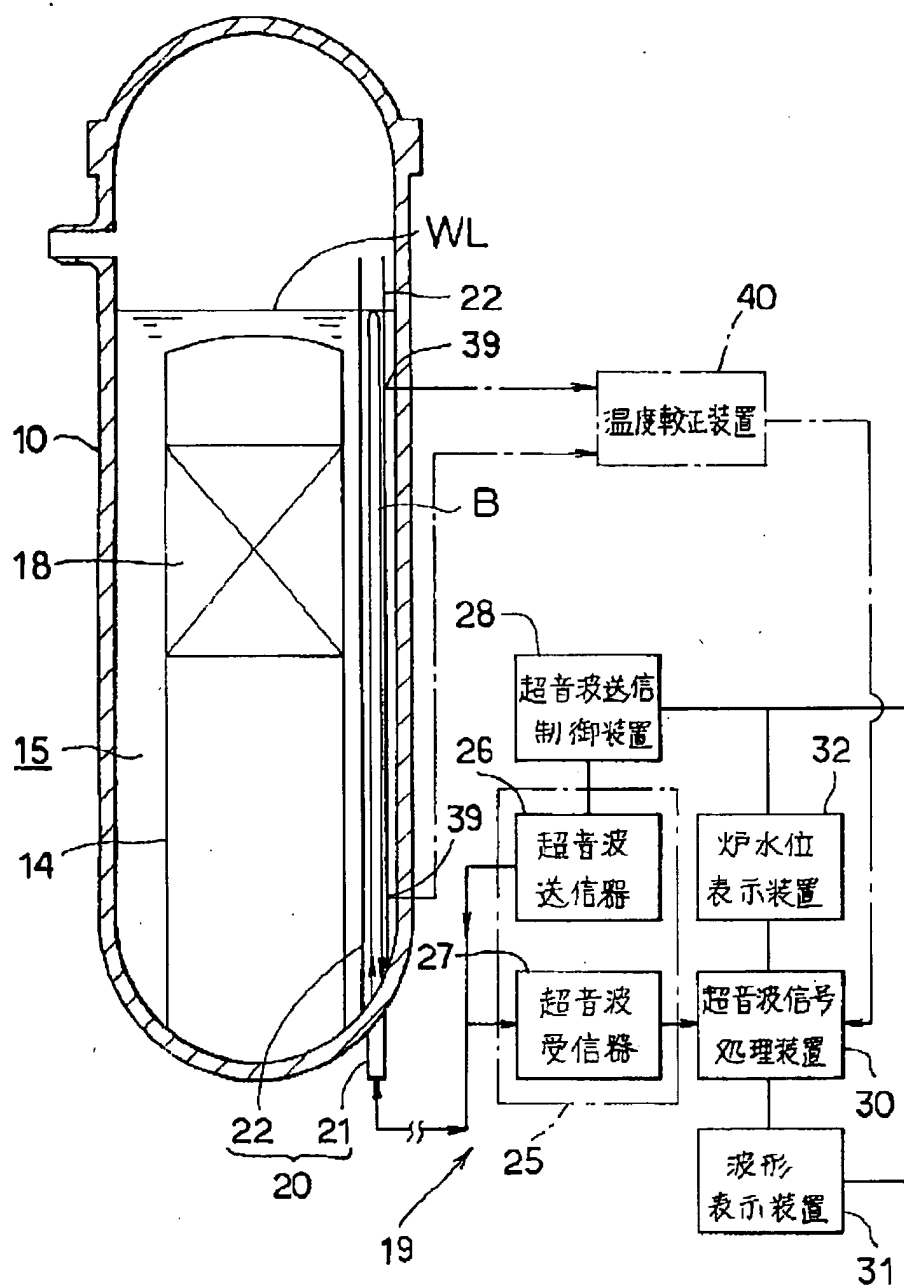
[Drawing 5]



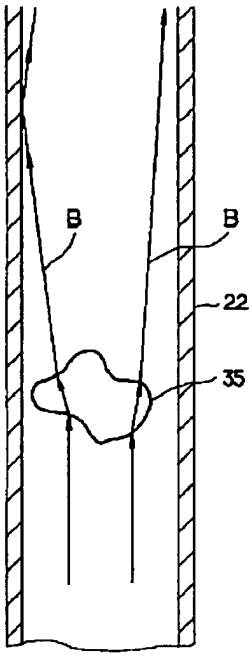
[Drawing 6]



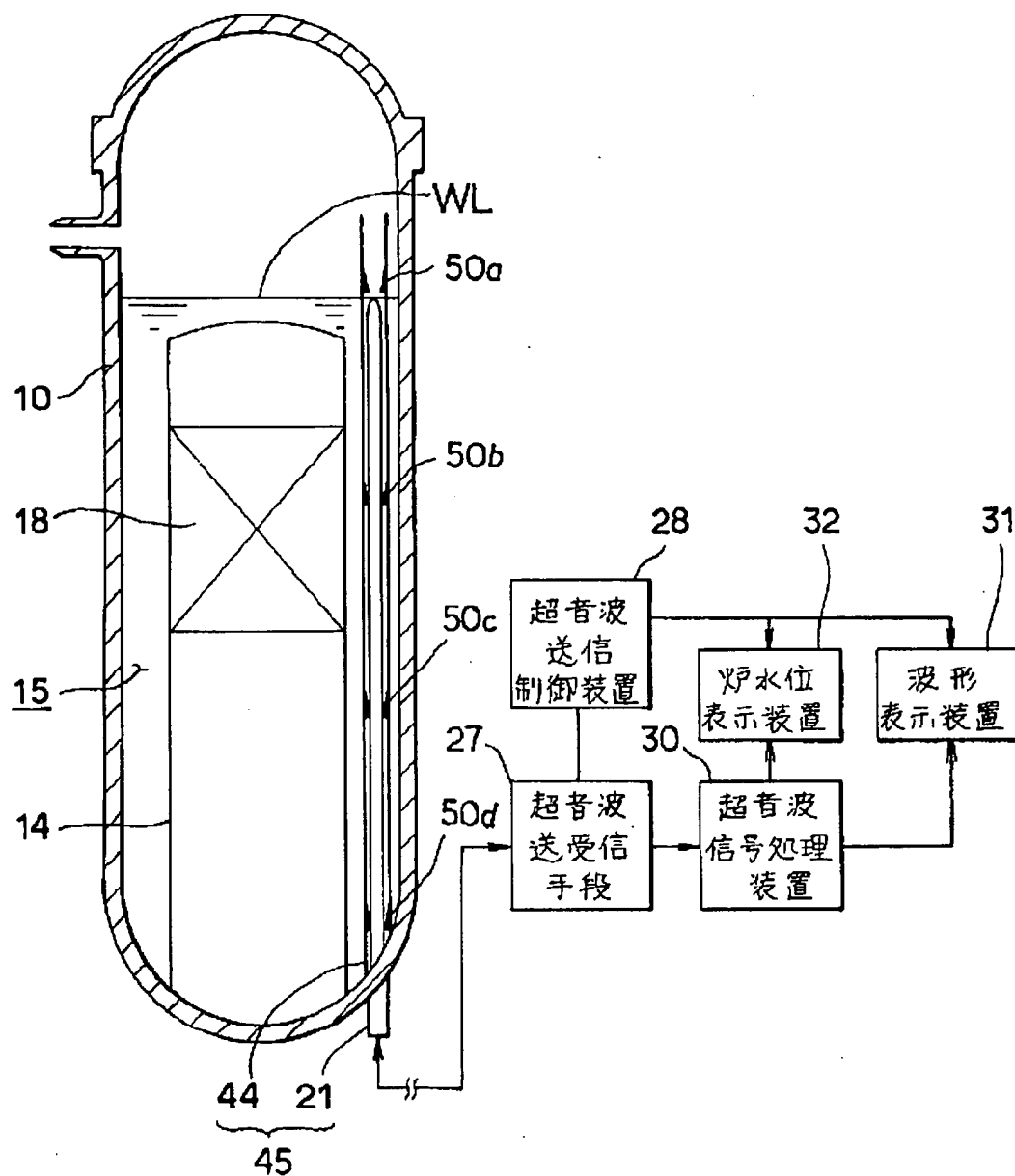
[Drawing 3]



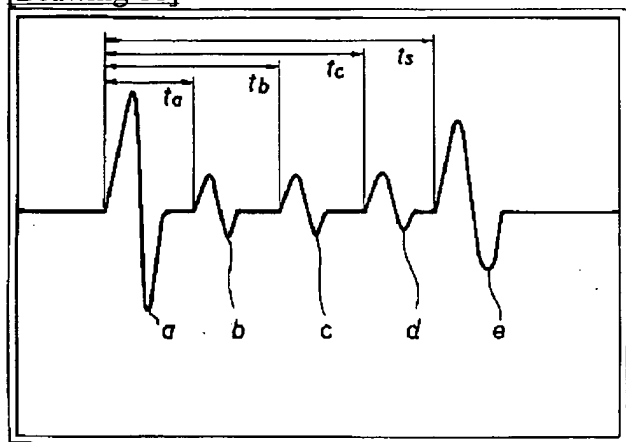
[Drawing 7]



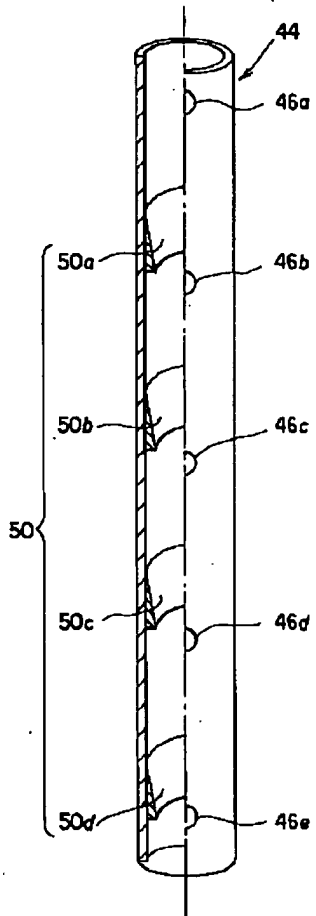
[Drawing 8]



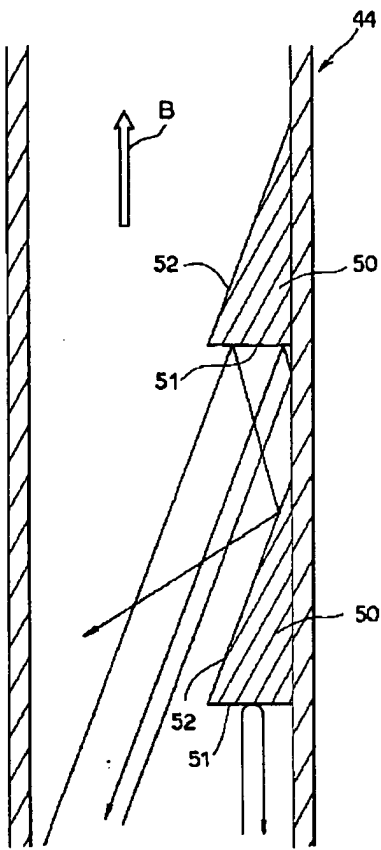
[Drawing 11]



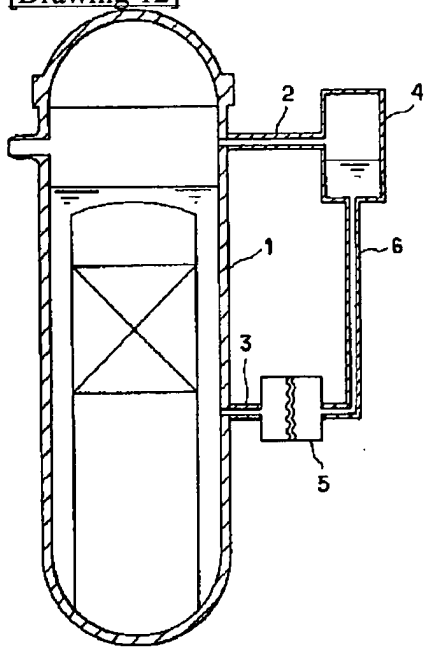
[Drawing 9]



[Drawing 10]



[Drawing 12]



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## DESCRIPTION OF DRAWINGS

### [Brief Description of the Drawings]

[Drawing 1] At least ultrasonic-type reactor water is the principle Fig. of a metering device.

[Drawing 2] Drawing showing the relation between the signal for ultrasonic transmission, and the received ultrasonic signal.

[Drawing 3] Drawing in which at least the reactor water concerning this invention shows one example of a metering device.

[Drawing 4] Outline drawing of an ultrasonic waveguide.

[Drawing 5] Drawing showing the relation between the signal for ultrasonic transmission, and the received ultrasonic signal.

[Drawing 6] The schematic diagram having shown signs that an ultrasonic beam was refracted when temperature distribution were in furnace water.

[Drawing 7] The schematic diagram having shown signs that an ultrasonic beam spread within an ultrasonic waveguide when temperature distribution were in furnace water.

[Drawing 8] Drawing of longitudinal section in which at least the reactor water concerning this invention shows other examples of a metering device.

[Drawing 9] Drawing fracturing and showing a part of ultrasonic waveguide with which a metering device is equipped at least with the reactor water of drawing 8.

[Drawing 10] The partial enlarged drawing of the ultrasonic waveguide of drawing 9.

[Drawing 11] Drawing showing the time relation of the ultrasonic input signal from which at least the reactor water shown in drawing 8 is obtained by operation of a metering device.

[Drawing 12] Drawing at least for the water of the conventional reactor to explain the measurement approach.

### [Description of Notations]

10 Reactor Pressure Vessel

14 Reactor Core Shroud

15 Downcomer Section

18 Reactor Core

19 At Least Reactor Water is Metering Device.

20 45 Ultrasonic propagation system

21 Ultrasonic Transducer

22 44 Ultrasonic waveguide

25 Ultrasonic Transceiver Means

26 Ultrasonic Transmitter

27 Ultrasonic Receiver

28 Ultrasonic Transmission-Control Equipment

30 Ultrasonic Signal Processor

31 Wave Display

32 At Least Furnace Water is Display.

39 Temperature Sensor  
40 Temperature Proofreading Equipment  
50, 50a-50d Ultrasonic beam reflective means  
51 Ultrasonic Reflector  
52 Ultrasonic Slideway

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